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ABSTRACT

The developmental memory research with children indicates that highly variable rehearsal leads to better overall recall and that the strength of interitem associations may play some role in improving recall. This paper reports on two experiments to investigate the interplay between the number and strength of interitem associations, and how each is affected by rehearsal. The first experiment, with 64 adult subjects divided into four groups, used related and unrelated words and high and low rehearsal variability. Results indicated that subjects recalled more words if they had either related items or high-variability rehearsal, but that having both offered no further advantage. In the second experiment, all the items were unrelated and the subjects had four study-test trials rather than one. Additionally there were three different types of high-variability, read-aloud rehearsals, each with three items in the rehearsal set. Analysis of variance indicated no significant effect of rehearsal type or recall. These experiments suggest that variable rehearsal's value for this type of memory task lies in its ability to establish large numbers of interitem associations which serve as multiple cues for recall. Continued rehearsal does not increase the strength of established associations. (BS)

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REHEARSAL AND INTERITEM ASSOCIATIONS

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I once asked a little girl in first grade what the word "memorize" meant, and she gave what I thought was a very precocious answer. She said, "Well, you see, your head is like a refrigerator. When you memorize something, it's like putting it in the refrigerator--it keeps it fresh for later." That's a nice answer. I also asked her how she went about putting something into her head that way, and she said that when she had to memorize something she would repeat it to herself over and over again. In other words, she would rehearse it.

A series of studies recently published in *Child Development* reported that children as young as 18 months did rehearsal-like things when trying to remember where a toy had been hidden (DeLoache, Cassidy, & Brown, 1985). They would talk about the toy and where it was hidden, for example, during the interval between hiding and finding. This tendency to rehearse increases steadily with age to the extent that it is one of the most frequently used memory strategies among elementary-school children (Flavell, Beach, & Chinsky, 1966). And of course, children who rehearse more also recall more (Garrity, 1975).

But why does rehearsal work? What is it about rehearsal that makes it so effective in helping us to put things into our heads, to keep these things fresh for later? In order to begin to answer these questions, and to understand the rationale behind the studies I will be describing today, it is necessary to look a little longer at the developmental memory literature, particularly at a study by Naus, Ornstein, and Aivano (1977).

In this study, third and sixth graders were shown a list

of words one word at a time, and were asked to memorize the words by rehearsing them in the interval between item presentations(1). Some of the children were given no special instructions as to how they should rehearse the words, as long as they did so aloud. It was found that the third graders tended to rehearse the words in a passive, rote fashion, usually practicing just one word at a time, or perhaps two. For example, if the first few words on the list were "apple," "hat," and "story," the younger children would be likely to rehearse them as follows: apple apple apple, hat hat hat apple, story story story, and so on.

The older children, on the other hand, were likely to use a more active and variable form of rehearsal. They would rehearse three or four items at a time, practicing the current item along with others that had been presented earlier on the list, in a more cumulative fashion. There was an age-related, qualitative change in the children's rehearsal.

The sixth graders, of course, also recalled more words than the third graders did. And this study showed that the age difference in recall was due, at least in part, to the developmental change in the kind of rehearsal the children used. The researchers included in their design groups of children who were instructed to rehearse exactly three different words together each time an item was presented. This manipulation improved the younger children's recall, because it required them to rehearse in a more mature fashion than they ordinarily would. Sixth grader's recall was not affected by the

instructions, because they tended to rehearse that way spontaneously.

But even though both age groups of children were rehearsing exactly three different items together in each rehearsal set, the sixth graders still recalled more words, and, these researchers discovered, they were still rehearsing more variably than the younger children. The second-grade subjects tended to "hold on" to the same two items, often the first two on the list, and practice those two words with each new one in order to include the required three items in each set: apple hat story, apple hat dog, apple hat flag, and so on. The older children were more likely to select from a variety of earlier items to make up their set of three words.

Younger children may rehearse the way they do because retrieving earlier items in order to rehearse them along with the current item takes more time and more mental effort for them than it does for older children (Guttentag & McIntyre, 1980; Medlin, 1982; Naus, Ornstein, & Aivano, 1977; Ornstein, Medlin, Stone, & Naus, in press). Be that as it may, the study I have just described suggests that rehearsal works to the extent that it is active and variable, and this conclusion has been verified in a number of other experiments (Medlin, 1982; Ornstein & Naus, 1978; Ornstein, Naus, & Stone, 1977).

For example, one such study (Medlin, 1983) used a read-aloud procedure (Ornstein & Naus, 1983) to control the degree of variability in rehearsal. In this procedure, subjects read aloud prepared rehearsal protocols, rather than rehearsing

on their own, in the interval between item presentations. (Read-aloud rehearsal has been found to be equivalent to self-generated rehearsal in terms of its effects on recall.)

It was found that highly variable rehearsal did improve recall more than rehearsal that was not highly variable but was identical in other respects. It was hypothesized that highly variable rehearsal established more associations among the items on the list, because they were rehearsed in ever-changing groupings over the course of a trial rather than simply one at a time. These interitem associations were thought to provide cues for recall, because recalling one item would cue the recall of its associates.

The study supported this hypothesis. Not only did highly variable rehearsal lead to better overall recall, it also led to better cued recall when the cue was one item from the list. In addition, subjects tended to recall the words in groupings that were similar to those in which the items were rehearsed. The author concluded that as rehearsal variability increased, the number of interitem associations established by rehearsal also increased. Memory was enhanced, therefore, because highly variable rehearsal increased the number of available recall cues.

However, it was also suggested that the the strength of interitem associations may also play some role in improving recall. For example, in a related experiment (Medlin, 1982), it was found that presenting the to-be-remembered words in the same fixed order on each of four study-test trials led to

better recall than randomly varying the order of the words on each trial. The fixed list order had a definite structure which was repeated in each trial, perhaps leading to stronger associations among items as they were repeatedly rehearsed together. The random list orders, on the other hand, would be expected to lead to more variable rehearsal, and a greater number of interitem associations overall, as each trial was different.

The purpose of the present research was to investigate this interplay between the number and the strength of interitem associations, and how each is affected by rehearsal. The rationale behind the first experiment was to have subjects rehearse words which already had either a very strong association to one another, that is, related words, or a very weak one, unrelated words. It was hypothesized that having related words or using highly variable rehearsal would improve recall, and that having both would be especially advantageous.

In Experiment I, 64 adult subjects were randomly divided into four groups with eight men and eight women in each. The experimental design consisted of two types of materials, related and unrelated words, and two levels of rehearsal variability, high and low. Ten lists of related words were constructed using Postman's (1970) norms of free association to such words as "garden," "doctor," and "letter." Ten lists of unrelated words were composed by taking two words from each related list and putting them in a random order. Thus each group saw the same words, but for some subjects the list was

made up of related words and for other subjects the list was made up of predominantly unrelated words.

Each of the 20 list items was printed on a large index card, and printed below the word was a prepared rehearsal set corresponding to that item. Subjects read these rehearsal sets aloud in the five-second intervals between item presentations. The rehearsal protocols were designed to simulate either high- or low-variability rehearsal. Highly variable rehearsal was, as in previous studies (Medlin, 1983), characterized by the grouping of each item with the two items that immediately preceded it on the list. The low-variability rehearsal was patterned after that of the younger subjects in the Naus, Ornstein, and Aivano (1977) study described earlier: the first two items on the list were carried through a majority of the rehearsal sets. Both types of rehearsal had three different words in each rehearsal set. Free recall was tested after the words had been presented and rehearsed in just once.

The results showed that subjects recalled more words if they had either related items or high-variability rehearsal, but that having both offered no further advantage. The mean number of words recalled was approximately eight for the group with unrelated items and low-variability rehearsal, and 11 to 12 for the three other groups. An analysis of variance showed significant main effects of sex (because women recalled, on the average, one or two more words than men), materials (with related items more easily recalled), and variability (as high-variability rehearsal led to better recall). The

materials-by-variability interaction was also significant. Subsequent comparisons among the group means showed that the group with unrelated words and low-variability rehearsal recalled significantly fewer items than the other three groups, which did not differ from one another.

One interpretation of these results is that highly variable rehearsal establishes interitem associations that are in some way similar to those which exist among semantically related words. However, the expectation that recall would be particularly improved by the variable rehearsal of related words was not supported. It might be assumed that, at least in just one trial, variable rehearsal does not strengthen preexisting associations. The purpose of the second experiment was to see if variable rehearsal might cause a progressive strengthening of interitem associations if continued over four trials. The idea in this case was to have three slightly different kinds of highly variable rehearsal, with each type intended to have a somewhat different effect on the build-up of associational strength over time.

Experiment II was very similar to Experiment I except that all the items were unrelated and the subjects attempted to learn the list in four study-test trials, rather than just one. In addition, there were three different types of high-variability, read-aloud rehearsal, each with three items in each rehearsal set. "Random" rehearsal was expected to allow little build-up of strength: each item was rehearsed with two other randomly selected words from the list. In contrast,

"blocked" rehearsal was designed to facilitate an increase in the strength of associations: the 20 list items were divided into four groups of five items each, and these five words were always rehearsed together as a group. "Standard" rehearsal was exactly the same as the high-variability rehearsal in Experiment 1, and was expected to affect the strength of interitem associations in an intermediate fashion.

An analysis of variance, however, indicated no significant effect of rehearsal type on recall. All three groups recalled an average of approximately 15 words per trial. Taken together, the results of these experiments suggest that the value of variable rehearsal, at least for this type of memory task, lies in its ability to establish a large number of interitem associations which can serve as multiple cues for recall. Once an association is established, continued rehearsal does not seem to increase its strength, or, perhaps, increasing its strength gives no further recall advantage.

I see these conclusions as tentative, and would like to try similar experiments with children, so that a more direct comparison can be made to the developmental studies which led up to this research. In any case, however, I believe the most fruitful approach to research on rehearsal will be to begin from the assumption that rehearsal works to the extent that it creates multiple interitem associations. Thank you for your attention.

Footnotes

- (1) Not all the groups included in this study are discussed here.

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